MOTOR SPEED CONTROLLER USING FUZZY LOGIC METHOD FOR PCB DRILLING OPERATION

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A report submitted in partial fulfilment of the requirements

for the award of the degree of

Bachelor of Mechanical Engineering

Faculty of Mechanical Engineering

UNIVERSITI MALAYSIA PAHANG

NOVEMBER 2008

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We hereby declare that we have checked this project and in our opinion this project is satisfactory in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering

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I hereby declare that this thesis entitled "*Motor Speed Controller using Fuzzy Logic Method for PCB Drilling Operation*" is the result of my own research and observation except quotations and summaries which have been duly acknowledged. The thesis has not been accepted for any degree and is not concurrently submitted for award of other degree.

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For my love Puteri Emme Marina, Family, Lecturers and Friends

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ACKNOWLEDGEMENT

I am grateful and would like to express my sincere gratitude to my supervisor Professor Madya Dr. Wan Azhar bin Wan Yusoff for his germinal ideas, invaluable guidance, encouragement and constant support in making this research possible. He has always impressed me with his outstanding professional conduct, his strong encouragement that he gave me. Without all his guidance and knowledge this project may not complete on time.

I also would like to give a gratitude to my university and also Mechanical Engineering Faculty for giving me an opportunity to do this project. In this project I have learn many new knowledge and experience. Not to forget to the University Malaysia Pahang for their entire relevant source that I use for this project

I also would like to give very special thanks to my family for their guidance, love, dream and sacrifice throughout my life. I am also wanted to give very special thanks to my love one for giving me the never ending support for me to finish this project. I am also grateful with my friends that never stop in helping me to complete this project. Thank you for all the support. Last but not least, i would like to thanks to all people that involve indirectly with this project. I hope this project can give a lot of benefit to the people and make new world a better place to live.

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ABSTRACT

This thesis is generally about how the mechanical system reacts when a load is given or friction is happen to touch the mechanical system. Every mechanical system will always be affected when there is a disturbance. Drilling operation is one of the common operations in the industry. When the drilling operation works, there must be a friction occurs when the work is done. Thus, there will be lack of performance for the drilling machine. The lack of the performance of the drilling machine will lead to the speed of the machine that will decrease slightly. That is the main part of this project. To make the performance of the drilling machine maintain, the speed must be increase as soon the friction is given to the drilling machine. To solve the problem, the Fuzzy Logic Method is use in this project. Using Fuzzy Logic Method, new equation will be finding and use it for this project. From the method, the speed of the motor will increase when the drilling operation is given a friction. There will be feedback for the error that the sensors detect from the drilling machine. The feedback will calculate the error and from the calculation the new increasing voltage will be determined. For the conclusion, the method is trying to find the new voltage for the drilling machine to maintain the speed of the machine. From the fact, we know that when the voltage in increase, the speed will also increase. Thus, the performance of the drilling machine will become more efficient.

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ABSTRAK

Tesis ini secara menyeluruh menceritakan mengenai bagaimana system mekanikal bertindak apabila beban atau daya geseran dikenakan pada sistem mekanikal. Setiap mekanikal sistem sentiasa akan terdedah dengan ganguan. Operasi mengerudi adalah salah satu operasi yang banyak di dalam industri kita. Apabila operasi mengerudi dijalankan, geseran pasti akan berlaku apabila kerja sedang dilakukan. Oleh itu, kebolehan mesin gerudi akan berkurang. Kebolehan mesin gerudi akan menyebabkan kelajuan mesin tersebut berkurang. Ini adalah bahagian paling penting dalam projek ini. Untuk meningkatkan kebolehan mesin gerudi. Kelajuan mesin gerudi mesti ditingkatkan apabila geseran dikenakan pada mesin gerudi. Untuk menyelesaikan masalah ini, Fuzzy Logic akan digunakan dalam projek ini. Menggunakan Fuzzy Logic, persamaan baru akan diwujudkan dan akan digunakan dalam projek ini. Daripada Fuzzy Logic, kelajuan motor akan meningkat apabila operasi mengerudi dikenakan geseran. Tindak balas akan berlaku apabila bacaan yang dikesan oleh pengesan mengenal pasti sedikit perbezaan dalam bacaan. Tindak balas tersebut akan mengira perbezaan tersebut dan daripada pengiraan tersebut, voltan baru akan dikenal pasti. Untuk kesimpulan, Fuzzy Logic akan cuba mengira voltan baru untuk mesin gerudi mengekalkan kelajuan asalnya. Daripada fakta, kita mengetahui bahawa apabila voltan dinaikkan, kelajuan turut akan ditingkatkan. Ini boleh menyebabkan kebolehan mesin gerudi turut meningkat.

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LIST OF SYMBOLS

π	-	pi
ω	-	Rotational Speed in rad/s
ω_m	-	Shaft Velocity of the Motor
φ	-	Magnetic Flux
AC motor	-	Alternate Current motor
D	-	Diameter
D	-	Duty Cycle
DAC	-	Digital to Analog
DC motor	-	Direct Current motor
e_b	-	Back EMF
F	-	Feed
I_a	-	Armature Current
i_a	-	Armature Current
K_e	-	Voltage Constant
K_m	-	Proportional Constant
MRR	-	Material Removal Rate
N	-	Rotational Speed in RPM
PCB	-	Printed Circuit Board
PD	-	Proportional Derivatives
PI	-	Proportional Integral
PV	-	Process Variable
PIC	-	Programmable Integrated Circuit

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PID	-	Proportional Integral Derivatives
PWM	-	Pulse Width Modulation
R	-	Armature Resistance
RPM	-	Revolution Per Minute
RTCC	-	Real Time Clock Counter
SP	-	Set Point
T	-	Torque
T	-	Overall Pulse Length
T_m	-	Motor Torque
T_{pulse}	-	On – Pulse length
V	-	Applied Voltage

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CHAPTER 1

INTRODUCTION

1.1 PROJECT MOTIVATION

Drilling Machines is used to make a hole and it is widely used in industry. Other processes for producing holes are punching and various advanced machining processes. The cost of holes making is one of the highest machining costs. There are several types of drilling which are gun drilling, twist drill, and trepanning. The most common drill is the conventional twist drill.

Many products used drilling as their major processes. Without drilling operation, the work cannot be done successfully. Drilling operation has been used in many sectors of industries such as automotive, piping, major industries also minor industries. The importance of drilling is increase by time because of the modern world and the used of high speed product in our life.

Drilling operation also used in electronic industries. One of the examples is to produce a hole on a circuit board. Even as tiny as a ants, it also need to use drilling operation. That show us how important is drilling operation.

Motor is a device that converts electrical energy to mechanical energy. Most of our activities will use motor to reduce the usage of human energy. This will reduce human responsible in daily life, not like the old days that many used human energy to produce works. There are two types of motor that are DC motor and AC motor.

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Motor speed controller is used to maintain the speed, increase or decrease the speed. It can give use our demanded speed. It used sensors to detect the right speed. This device is important to the society. The sensor detects the problem and recover it automatically without human command at that time but it is already calculated it the programming. The scope of motor speed controller is very wide, such as in domestic applications, office equipments, medical equipments, commercial applications, industrial applications, vehicle applications and many more.

1.2 PROJECT BACKGROUND

In drilling operation, there is many error can occur if the step to use drilling machine is not followed. The friction that occurs between the drill and workpiece will reduce the speed of the motor. When the speed is reduce, the performance of the drilling machine will also decrease and it will operate less efficient. This will affect to the workpiece. To avoid it, the rpm of the motor must be increase. To increase the speed, the voltage also must be increase. Increase in voltage will increase the speed.

To control the speed to the demanded speed or maintain the speed, Proportional integral derivatives (PID) controller can be use in the drilling machines. PID controller is the combination of PD controller and PI controller. PD controller can add damping to a system, but the steady state response is not affected while PI controller can improve the relative stability and improve the steady state error also but the rise time is increased.

To increase the voltage, the driver amplifier can be use in the drilling machine. Amplifier will make the input resistance is higher than output resistance. When the ratio of input over output resistance is high, the voltage will also increase (Ryan Sherry, 1995; Hulick T.P., 1989).

There are 2 types of motor which are DC motor and AC motor. There are several type of DC motor such as permanent magnet DC motor, separately excited DC motor and series DC motor. Permanent magnet DC motor will be used in this project. The magnetic field of a permanent magnet DC motor will collide with electromagnetic field

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and produce a rotation of the motor. This motor will make the drilling rotates and the higher voltage means the increasing in speed of the rotation (Germanton et al, 1999).

To detect whether the speed is reduce or not, the sensor can be use in this project. The sensors that will be use are encoder. Incremental encoders are used for converting linear or rotary displacement into digital coded or pulse signals (Benjamin C. Kuo, 1995). When the signal is receive, it will go back to the speed controller, amplifier and permanent magnet DC motor. This is to increase the voltage and to achieve to the demanded speed.

Fuzzy logic will be use as the method to solve the problem. Fuzzy logic will be applied in the speed controller. A programming code will be created in the system.

In this project, an efficient and reliable DC motor will be build based on Fuzzy logic method to control the speed of the DC motor in the drilling machine.

1.3 PROJECT PROBLEM STATEMENT

The problem in this project is the decreasing speed of the drilling machine. Reducing in speed will affect the performance of the drilling machines. The performance of the machines also will affect the efficiency of the machine. This phenomenon occurs when there is friction between the drill and the workpiece.

When the speed is reduces, means the RPM of the drills is reduces. When the RPM is reduces, the material removal rate also will reduce. Means, this also will affect to the power of the drill. Thus, the torque of the drill also will be decrease (Serope Kalpakjian, 2001).

The excellent drilling operations happen when the speed of the drill is maintain. Means, the rpm of the drill must be increase to the demanded speed. To increase the speed, the voltage of the motor also must be increase. The problem will be detected by the sensors and when the sensors sense the decreasing of the speed, amplifier will increase the voltage of the motor (Germanton et al, 1999). Thus, it will also increase the

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speed of the drill. This process required programming code to go through with the process.

The problem for this project is to correct the speed of the motor and it will be solve by using fuzzy logic method.

1.4 PROJECT OBJECTIVES

The project research objectives are:-

i. To build the circuit of motor speed controller.

ii. To make a programming code for fuzzy logic method.

iii. To make sure the PCB drilling works accurately.

iv. To maintain the speed of drilling machine.

1.5 Project Scope

The project research scopes are listed as below:-

i. The motor speed controller is only an experimental and not readily use for commercial product.

ii. The motor speed controller can be use only for PCB drilling

iii. Permanent magnet DC motor is the only type of motor will be used in this model

iv. The parameter that will be considered is only the frequency of the motor

v. Sensors that will be use is encoder

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1.6 PROJECT REPORT ORGANIZATION

The rest of the reports are organized as follows:

Chapter 2: literature review and background knowledge of motor speed controller and fuzzy logic method. Explain briefly about the methods on how to use fuzzy logic. Find the easiest way to find the solution using fuzzy logic method. The project will be discussed about the advantage and disadvantage of using fuzzy logic method at motor speed controller.

Chapter 3: Design and Methodology of the motor speed controller will be built in the simplest design and using the simplest equation to make the product is working perfectly. Finally all the components will be assemble and ready to use for the presentation.

Chapter 4: Results will be taken twice and are presented

Chapter 5: Project Conclusion and the recommendation will be added and the device will be improved from time to time for the future project works. All the recommendation will be presented.

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CHAPTER 2

LITERATURE REVIEW

2.1 DRILLING OPERATION

Hole making is one of the most important process in manufacturing (Serope Kalpakjian, 2001). One of the methods to make a hole is by drilling operation (Osawa et al, 2005). Drills basically have high length to diameter ratios, thus they are capable to produce a deep holes (Serope Kalpakjian, 2001). However, the friction will occur when the drills touches the surface of the work piece (Serope Kalpakjian, 2001). This situation will make the rpm of the motor decreasing and this will make the hole making less accurate as it should be from theoretically. There are several type of drilling which are gun drilling, twist drill, and trepanning.

Material removal rate (MRR) in drilling is the volume of material removed per unit time. Below is the equation for MRR;

$$MRR = (\pi * D^2/4)FN$$

Where, D = diameter of the drill

F= feed (the distance the drill penetrates per unit revolution)

N = rotational speed in rpm

From MRR equation, reduce in speed will reduce the value of MRR. This will make the performance of the drill less efficient and power. To make the drilling operation increase, the rpm of the drill must be increase. We can see the lack of power

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using power equation. Below is the equation to calculate power required for drilling machines;

Power = MRR * specific energy

Furthermore, speed also affect on the torque of the drill. Below is the equation to calculate the torque of the drill;

T = power/ω

Where, ω = rotational speed in rad/s (speed of one rotational per unit time)

Figure 2.1: Drilling operation (http://www.electricstuff.co.uk/drill.jpg)

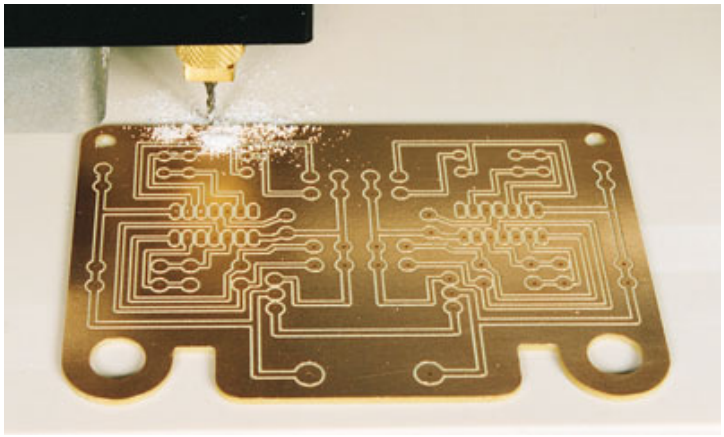

Figure 2.2: PCB drilling (http://www.techsoftuk.co.uk/pcb_drilling.jpg)

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